Collecting Samples from the Máaz Formation of Jezero Crater with the Mars 2020 Perseverance Rover

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Collection of samples that could be returned to Earth from the floor of Jezero, a Noachian crater characterized by a delta–lake system with high potential for habitability, is a major goal of the Mars 2020 mission. The Mars 2020 Perseverance rover is currently exploring the Máaz and Séítah formations to the southeast of the delta. Here we focus on the crater-retaining Máaz formation, a widespread, rough and fractured terrain with lobate margins mapped in orbital images, e.g. [1]. Outcrop morphology and texture, as well as the appearance, composition and mineralogy of abraded rock surfaces observed by Perseverance suggest that the Máaz formation consists of a sequence of mafic igneous units, likely lavas flows. These rocks have experienced variable interaction with aqueous fluids. Type localities of the lower Roubion and the more resistant Rochette members of the Máaz formation have been targeted and their abraded surfaces characterized prior to sample collection. In this presentation we will summarize these sampling activities and potential future sampling of the heavily cratered upper Ch'ał member that is indicative of the Máaz formation from orbit.

A pair of cores, and their companion abraded patch, were acquired on a small tabular boulder (Rochette, ~40 cm across) located in a NW—SE-trending outcrop on top of the Artuby ridge crest. Artuby forms a km long scarp exposing Máaz formation stratigraphy that borders the region of Séítah explored by the rover. Rochette was selected for coring primarily for its accessibility, limited relief, and perceived resistance to disaggregation during coring. Additionally, its position on Artuby ridge places it stratigraphically above and potentially younger than Séítah and other Máaz rocks including the Artuby and Roubion members.

Rochette is holocrystalline with no intergranular porosity or evidence of matrix cement. From elemental data the 0.2-0.5 mm, intergrown light and dark minerals are pyroxene and plagioclase consistent in composition and texture with a basalt (or microgabbro). Secondary features include brown iron-rich patches, especially evident around white patches that may reflect cavities filled by secondary minerals such as Ca-sulfate (occasionally hydrated), sodium perchlorate, and phosphate. Carbonate and amorphous or microcrystalline silicates were also identified along with several types of aromatic organic signals.

Laboratory analyses of Máaz samples returned to Earth will expand exploration of Jezero and Mars. The timing of Rochette's crystallization will help constrain the emplacement ages of other crater floor units.

Likewise, if the surface exposure and exhumation history of Máaz can be understood, then the geochronology may quantify, or constrain, the duration of crater accumulation and retention at the exposed Jezero floor. Such information could then be used to test, and potentially quantify, fundamental parameters assumed in Mars crater chronology functions. Paleomagnetic studies of these samples can constrain the lifetime of the martian dynamo and test the hypothesis that loss of an early magnetic field drove atmospheric loss. Analyses of the secondary minerals will provide information on the chemistry and environmental conditions (e.g., pH, temperature, salinity, timing) of Rochette's aqueous alteration. Organics, if preserved, would provide information on the martian carbon cycle. Water-soluble salts (e.g., halite and/or perchlorate), apparently filling holes, suggest addition of secondary phases from an aqueous fluid documenting the final aqueous interaction experienced by this rock. Similar salts on Earth are known to contain organic molecules and even fossilized microscopic life.

[1] Stack, K.M. et al. (2020). Photogeologic Map of the Perseverance Rover Field Site in Jezero Crater Constructed by the Mars 2020 Science Team. Space Science Reviews, 216, 127, dos:10.1007/s11214-020-00739-x.